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The Reverse Tragedy of the Commons: An Exploratory Account of Incentives for Under-exploitation in an Open Innovation Environment¹

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Abstract

This paper presents an empirical account of a phenomenon that we refer to as the ‘reverse tragedy of the commons’ in open innovation. The name signifies the ‘under-exploitation’ of intellectual property under weak appropriability. The name is this graphic because the tragedy is costly, and can also render intellectual property effectively worthless and block innovation in the short to medium term. We propose that the tragedy is borne out of the interaction between enterprise characteristics, a competitive setting and the framework that is set by the policy intervention. This finding is pertinent to policy makers with regard to the design of research, development and innovation instruments, as well as managers who must determine how to implement open practices in innovation.

1 Introduction

Innovation is high on the agenda in public policy (European Commission 2014) as well as private strategizing. As various policy instruments, such as research, development and innovation (RDI) funding programs, are developed, there is a discussion on the interactions between and externalities of instruments within ‘policy mixes’ (Flanagan, Uyarra, and Laranja 2011; Paraskevopoulou 2012).

To inform this discussion, this paper presents an exploratory empirical account of a phenomenon that we refer to as the ‘reverse tragedy of the commons.’ ‘The tragedy of the commons’ (Hardin 1968; Hardin 1998) proposes that that public goods² or commons are bound to be overexploited and depleted, because the negative externalities of exploitation are collectively borne by all stakeholders while the individual exploiters bear the benefits (Hardin 1968; Hardin 1998). The ‘reverse tragedy of the commons’ happens when stakeholders under-exploit a common resource. We propose that this under-exploitation results from the properties of public goods and incentives for commercialization. We focus on the exploration of the reverse tragedy and its implications. The empirical account is from a publicly funded center of expertise program established to bridge the gap between research and innovation. The program had exceptional conditions for intellectual property (IP), which makes the program a laboratory to examine behaviors in low-appropriability regimes.

This paper offers two main contributions. First, it outlines a new phenomenon important for innovation research, specifically the discussion on the relationship between the external environment and benefits to Open Innovation (OI) (Huizingh 2011; Dahlander and Gann 2010). The observed reverse tragedy poses a challenge for effective collaboration. We propose that this under-exploitation is driven by a set of factors that are associated with the sharing of public goods, including organizational incentives, trust, the cooperative setting, and the framework set by the policy intervention. Second, this study explores the challenges for OI policy instruments, thus contributing to the discussion on policy instruments and mixes. It identifies a potential contradiction between the intended outcomes of innovation policy and the actual behavior of firms in OI. Additionally, the research has some implication for management, as discussed below.

² Public goods (commons) are resources that are non-rival and non-excludable, i.e., that cannot be excluded from public consumption and individual consumption does not exclude others from consuming the resource (Samuelson 1954)

2 The literature review

This section discusses the theoretical perspectives on competitive advantage and innovation to provide a theoretical lens for analysis (c.f. Dubois & Gadde 2002). First, we examine the relationship between the tragedy of commons and IP as a source of competitive enterprise advantage. Second, we discuss the so-called first-mover advantage and the incentives for the commercial exploitation of public goods.

2.1 Tragedy of commons, knowledge assets and competitive advantage

As discussed, the tragedy of the commons is the theoretical proposition that an 'unmanaged' commons is depleted by over-exploitation because (short-term) individual incentives increase the exploitation of the resource until consumption is unsustainable (Hardin 1998). However, there is evidence that such a tragedy is not a given and that commons may even be 'under-exploited' (Feeny et al. 1990).

The literature on commons debates whether higher education institutions serve as a common pool (e.g., Ostrom & Hess 2007; Madison et al. 2010; Frischmann 2005). Also the effects of patent pools or thickets (Lerner and Tirole 2008) as well as patents as anti-commons have been discussed (e.g., Chang and Yang 2008; Murray and Stern 2007). We take a new perspective and specifically examine the commercial exploitation of IP that is created in collaborative research projects and has very low appropriability.

The resource-based view of the firm (RBV) posits that the competitive advantage of an enterprise is built on proprietary resources, which include intangible assets that range from registered IP, (intellectual property rights, IPR) and trade secrets to routines, processes and know-how (Winter 2003). The RBV proposes that at any given time, the competitive position or advantage of an enterprise is based on unique resources (e.g., Peteraf & Barney, 2003). Further the dynamic capabilities enable the recognition, acquisition and configuration of unique resource bundles for exploitation (Teece, Pisano, and Shuen 1997; Teece 2007; Eisenhardt and Martin 2000; Winter 2003; Danneels 2008), for example through RDI or networking (Eisenhardt and Schoonhoven 1996).

Arguably public information may create value when it is exploited by an enterprise with superior capabilities (Eisenhardt and Martin 2000; Winter 2003; Danneels 2008). However, this means accelerated competitive imitation and learning (Peteraf 1993) and low appropriability requires high capabilities (Ahn et al. 2016). While collaboration may be generally beneficial (Ahuja, Lampert, and Tandon 2008), it is difficult *not* to transfer knowledge in intensive collaboration (Bresser 1988).

In this view, exploiting public goods creates a basic tension between the interest to create economic rents and sharing the knowledge for a common good. However, an enterprise may be compelled to share information if the probable return is greater than the probable damage (Simeth and Raffo 2013). Such incentive might be risk sharing or the possibility of tapping into new complementary assets (Enkel, Gassmann, and Chesbrough 2009). Arguably collaborators also have a better ability to absorb and use the knowledge (Cohen and Levinthal 1990) than outsiders.

2.2 First-mover advantage and competition

The first-mover advantage (FMA) is the proposition that the first enterprise to introduce a new product category to a new market holds a significant and sustained advantage over the followers in market share and investment return. For consumer goods, it is held that preferences are shaped by the first innovator around its offering, which creates a 'lock-in' effect (Robinson, Kalyanaram, and Urban 1990).

However, often the first mover does not hold an advantage, but rather the early follower (Golder and Tellis 1993). The probability of gaining FMA is higher in stale markets with slow technology progress. If technology changes fast, then FMA is less likely as each successive product generation poses the risk for the pioneer. When markets are changing fast, FMA is also less likely as customer base and preferences also change fast (Suarez and Lanzolla 2007). Teece (1986) proposed that when information approaches being a public good, the benefits from knowledge tend to shift for enterprises with 'complementary assets', which may translate into an incumbents' advantage (Rothaermel 2001). Other studies have shown that uncertainty on returns may either contract or expand RDI investments (Ahuja, Lampert, and Tandon 2008); low RDI cost may induce a 'race' to be the pioneer, while high cost may lead to a 'waiting game' to seek the second-mover advantage (Hoppe and Lehmann-Grube 2001).

2.3 Synthesis

The existing research proposes that sustained competitive advantage is based on a stock of resources and dynamic capabilities to acquire, configure and exploit the resources to create value. In this scheme IP is an important resource. Further, to remain competitive, enterprises must replenish their resources ahead of their immediate competition and use their capabilities to reconfigure them.

The research on competitive advantage silently assumes that enterprises seek to compete and outmaneuver each other either directly or by diversification and that over-exploitation is the logical end of the development. However, there is a tension between the assumptions and the data that are presented below. As the literature review also suggests, there are incentives whereby it may appear to be more rational to refrain from engaging in RDI, which may to 'under-exploitation' of assets.

The anticipated return to RDI investment and the commercial rationality of such an investment depends on the ability to harvest rents from the markets. As discussed above, the initial innovator often cannot reap significant rents. Consequently, when the (possibility of) competition prohibits rents, market leaders may displace themselves voluntarily from leadership (Pacheco-de-Almeida 2010). The aversion towards innovation is exaggerated by high RDI costs, as innovation may be perceived as a costly journey to the same competitive situation (Hoppe and Lehmann-Grube 2001).

3. Methodology

3.1 Study design

This study is an exploratory case study research. We derive propositions from 'critical' cases, that serve as a basis for analytic generalization (Patton 1990; Yin 2003). The analysis is based on the matching of the observations to theoretical concepts through systematic combination (Dubois and Gadde 2002; Dubois and Gadde 2014). In practice, there is an interplay between theory development and data analysis in the act of pattern matching to draw proposals for causal inference.

Specifically, we examine two ‘Strategic Centers of Science Technology and Innovation’ (SHOKs³). The SHOK program was an excellent opportunity to examine the phenomenon of commercialization of public IP, as it had an exceptional scale and included the main actors of the respective industries within the Finnish national economy. The data were gathered between May and September 2012 during an evaluation of the SHOK program. The data collection was executed by a consortium of researchers and consultants.

The dominant sampling logic for data collection was purposive (Palys 2008). The interviewees were selected from the stakeholders based on their assumed ability to give informed answers. The interviewees included SHOK CEOs and CTOs and their equivalent; representatives of funding bodies; researchers, RDI managers, and employees from the collaborative projects; and policy makers who were involved in the design and implementation of the program. The survey was conducted as a part of the evaluation, and in the context of this paper, it is primarily used for context. The data have been re-examined and re-coded for the purposes of this paper.

Table 1: Details of data

Data source	Sampling and collection	Coding and interpretation
Documents	A document database of annual reports, monitoring data and other relevant materials from the SHOKs.	The data were coded by each responsible SHOKs investigator. Description of each SHOKs output, form and context.
Semi-structured interviews	A series of interviews with SHOK personnel, participants of the research programs and stakeholders. The interviews were semi structured, administered either at the interviewees premises/place of work or over the phone and noted in field notes. Interviews were conducted until data saturation was reached, between May and September 2012	The data were coded by each responsible SHOKs investigator. Bottom-up coding to emerging themes
A cross-sectional panel survey	The survey explored the expectations, perceptions and experiences with the SHOK instrument among the involved companies and research organizations. A pre-test was done between the June 1st and 4th, and implemented between June 11th and the 29th. The surveys for participants and program administrators received 1580 (27% response rate) and 676 (25% response rate) answers, respectively.	Survey analyzed by core team of evaluators. Cross SHOK-findings on outputs and the program in general.
Group interviews	A series of group interviews conducted during a series	Independent expert judgment on

³ SHOK is a Finnish acronym, from ‘Strategisen Huippuosaamisen Keskittymä,’ literally Center of Strategic Expertise/Excellence.

	<p>of peer review panel meetings.</p> <p>The interviews were led by the five-person panels composed of leading academics in the fields of the SHOKs.</p> <p>The interviewees were SHOK program managers and participants.</p>	<p>the SHOKs research quality and implementation in general.</p>
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3.2 Empirical context⁴

3.2.1 Background and overview to program output

The founding of the SHOK program was prepared 2005-2006. The aim of the program was to establish public-private partnerships to accelerate innovation and renewal of industries. The SHOKs were designed to be OI platforms to bridge the continuum from basic research to innovation and exploitation. The program was expected to create new patterns of cooperation, co-creation and interaction.

There were six SHOKs in operation: CLEEN Ltd (in the area of environment and energy), FIMECC Ltd (in the machinery industry), SalWe Oy (in health and wellness), DIGILE (in the ICT and digital services sector, previously known as TIVIT) RYM Ltd (in the built environment sector) and the Finnish Bioeconomy Cluster FIBIC Ltd (forest-based industry, previously the Forest Cluster Ltd.).

The SHOK program became one of the main instruments of Finnish innovation policy and perhaps even its ‘flagship’ program in its runtime. From September 2008 through September 2012, Tekes funded the SHOKs and their programs with a total of over EUR 343 million. An average of 40% of the research that was conducted in the SHOKs was co-funded by the involved companies.

The evaluation of the program found that most of the SHOKs largely failed to achieve the program objectives (Lähteenmäki-Smith et al. 2013). Measured by the program’s Key Performance Indicators (KPIs) and the participants’ experiences and satisfaction, the impact of the SHOKs was relatively low. The activities produced relatively few commercial outputs, and the objective for creating new business was only partly met. In terms of specific IP issues, Overall, the conclusion was that the then-current combination of actors and program conditions did not provide sufficient incentive for commercialization.

Particularly the commercialization activities were relatively modest. The highest achiever in terms of the number of invention announcements and secured patents, the FIBIC reported a total of 34, while the highest number of licenses that were sold was reported by the FIMECC was 46. Extremely few spin-offs were reported, FIMECC was the “best-in-class” with three. In the survey, the participants were asked about the effect of SHPOK to IPR creation, Cleen represented the most positive picture, with 30% having felt an impact in these terms, while the fraction for TIVIT/DIGILE was 25%, and for FIBIC a mere 11%.

Due to these findings, the stakeholders who were interviewed were asked about IP regime, and consistently stated that the T&C were adequate, well-defined and clearly communicated. Critical views

⁴ Adapted and reinterpreted from (Lähteenmäki-Smith et al. 2013) and associated secondary data.

were expressed though by some interviewees, the panels, as well as the survey. Similarly over 50% of the surveyed across all SHOKs indicated that IPR issues were not sufficiently resolved and that was reflected in the output, incidentally in FIBIC the number was 80%.

3.2.2 Terms and Conditions for the Coercive Open Innovation Regime

One of the distinguishing features of the SHOK program was the IP regime. During the data collection period, all of the research programs used Tekes funding. Thus, the Tekes general terms and conditions (T&C, “General Terms and Condition for SHOK Research Programme Funding” 2012) outline the framework conditions.

The T&C in effect established a coercive OI regime. While the ownership and title as well as material and immaterial rights to any results materials and IP remained with the inventor, who could also protect the IP, the T&C mandated an unlimited and perpetual access right to any resulting material and IPR to all of the participants within the respective research programs, including any entities within the same group of companies. If participants left the program, their access right to IPR would remain in force, but they would lose preferential treatment in access to background or resulting materials that were owned by other participants.

4 Case Descriptions

We chose two of the six SHOKs, Finnish Bioeconomy Ltd. (FIBIC) and DIGILE Ltd., for further analysis for the following reasons: First, they were the longest running SHOKs, and FIBIC has represented forest-based industries since 2007 and DIGILE IT and telecom since 2008. Second, at the time of the data collection, the research programs were large (up to 4 years in duration and budgeted up to EUR 20 million annually), and they included a broad-based cooperative (up to 20 participants) consortia.

4.1 Case A: FIBIC

FIBIC (Finnish Bioeconomy, orig. Forestcluster Ltd.) was founded in 2007 as the first SHOK to renew the forest industry through new RDI networks. As with other SHOKs, FIBIC has a Strategic Research Agenda, which is implemented by collaborative research programs (c.f., Lähteenmäki-Smith et al. 2013).

The forest industry is a mature industry that is dominated by multinational companies. The key challenges in the forest industry are related to the profitability of the industry, renewal, and research reorientation. The programs produced business ideas, invention disclosures, publications and patents. However, the utilization of the results was seen as being highly problematic due to the blanket license to IP across the consortium. Further, there was clear evidence that, due to the obligation to share results, the most commercially lucrative research topics were not included in the programs.

Besides IPR issues (c.f. Table 2), the first tier forest conglomerates were reluctant to commercialize as the market demands were unclear, which together halted innovation. The lower-tier chemical and equipment suppliers could not exploit the IP either because their customers in the first tier were not interested. These findings correspond well with the description of the reverse tragedy of the commons, which is enabled by very low appropriability of IP. Multiple factors exacerbated the issue as the technology was moving relatively fast, the markets were highly volatile or unknown, the RDI costs were high, and the enterprises were, on average, well resourced.

Table 2: Summary on interviews

Informant/source	Statements relevant IPR, incentives and commercialization	Emerging themes
Large forest enterprises	<ul style="list-style-type: none"> Once a research program is running, how does one spin out common IPR? These difficulties may prove critical, as companies want to have results for themselves Truly interesting research done by companies themselves Fierce rivalry for best research resources 	<ul style="list-style-type: none"> IPR issues blocking research ideas IPR is underutilized/exploited Lack of commitment Avoiding truly interesting topics in research programs
Chemical and equipment suppliers	<ul style="list-style-type: none"> SHOK concept is less efficient than expected Real development is not brought into FIBIC, only elsewhere IPR issues a bottleneck No1. Common ownership of results does not work. Lack of general commitment, as the concept must be sold internally to top management each year. Too much openness hinders commercialization 	
Academia	<ul style="list-style-type: none"> They do not see the IPR as an issue Protection by publishing [which in fact exacerbates the challenges] Companies do not bring topics relevant to competitive edge into FIBIC 	
FIBIC	<ul style="list-style-type: none"> Cartel history is a significant source of challenges in the level of cooperation Companies are reluctant to tell what they really do IPR issues, free license to utilize does not work The step from research program to company based activities is difficult 	
Panel meetings, five senior researchers, interviewing SHOK managers, program directors, researchers and boards members in separate sessions. (20 interviewees plus 5 panelists)	<ul style="list-style-type: none"> Unclear how to move from pre-competitive to competitive research objectives within the SHOK The IPR issues are unresolved 	

4.2 Case B: DIGILE

At the time of the data collection, DIGILE (orig. TIVIT) ran six programs with large and small enterprises and research institutes. The challenge was also the reinvention of business models for Finnish IT and telecom.

The industry structure was similar, although there was a more clear distinction between a few large technology-driven enterprises and small, typically service-oriented enterprises.

The first finding is that the DIGILE programs produced relatively little IPR compared to previous similar public RDI interventions. The preceding Tekes run RDI subsidy program produced orders of magnitude more IPR for the equivalent funding and runtime (Lähteenmäki-Smith et al. 2013, 186). The main explanation was that the bulk of the RDI activities took place in the pre-commercial and pre IPR registration phase. However, the DIGILE documents and the interviewees indicated that the programs were focused on innovation as opposed to pre-commercial research.

The circumstances surrounding the DIGILE programs are analogous to that of FIBIC. Similarly, technology moves fast, markets are volatile, RDI costs are high, and several well-resourced enterprises are involved. However, in DIGILE, we cannot find as clear-cut case of the reverse tragedy of the commons. This is arguably because of faux-collaborative behaviors in the programs (c.f. Table 3). The interviews suggest that the programs exhibited nominal investment in a program and staffing the collaborative projects with second-tier RDI employees to acquire interesting IPR, and private parallel development projects. These findings reinforce the notion that the coercive OI regime poses incentive problems.

Table 3: Summary on interviews

Informant/source	Statements relevant IPR, incentives and commercialization	Emerging themes
DIGILE	<ul style="list-style-type: none"> • Programs have a position in creating platforms/scalable ecosystems • IPRs less sensitive as activities focused outside daily business • IPRs are more sensitive for small-to-medium enterprises (SMEs) 	<ul style="list-style-type: none"> • The T&C that set-up a coercive open innovation regime pose perverse incentives for IPR and commercialization • Sensitive for SMEs, due to narrow IPR base, and for large enterprises due to the risk unwanted spill overs • Competing interests for research agenda and cooperative relationships amplify the IPR issue
Funding organizations	<ul style="list-style-type: none"> • It is suggested that the programs serve as a venue for idea exchange and RDI is done privately • There is a risk that large (multinational) enterprises gather IPRs and spread them around 	
Large enterprises	<ul style="list-style-type: none"> • T&C for IPR is challenge for committing enterprises • The T&C are a strong disincentive for contributing to the RDI, the present terms do not allow any appropriability • The model does not handle competing interests in the consortium • The terms inhibit especially SME participation 	
RDI director and SHOK program participants (2 persons), SME software and service	<ul style="list-style-type: none"> • Large enterprises dominate the agenda, every participant have their 	

	<p>own agendas, programs are focused on things that would not be developed otherwise (non-core RDI)</p> <ul style="list-style-type: none"> • Freeloading is common (participating organizations commit in name only) • Commercialization is challenging due to the joint venture –nature of RDI 	
Academia	<ul style="list-style-type: none"> • The SHOKs operate uncomfortably close to commercialization; enterprises do not share their best ideas and efforts • IPRs are a constant source of friction in the programs 	
Panel meetings, five senior researchers, interviewing SHOK managers, program directors, researchers and boards members in separate sessions. (20 interviewees plus 5 panelists)	<ul style="list-style-type: none"> • The panel concluded, based on hearings, that IPR registration and not creation was substantially hampered by mandatory IPR sharing 	

4.3 Cross Case Analysis

These findings suggest that a coercive OI regime introduces perverse incentives for IPR creation and/or commercialization. In the case of DIGILE, the incentive problem seems to manifest as lack of created IP, whereas in FIBIC the manifestation is lack of commercialization.

The first plausible explanation for the difference is the balance of power in the programs. Several of the FIBIC programs involve large multinationals that compete in their core business areas, together with their mutual suppliers and technology partners. The major driver for the reverse tragedy is the cooperative relationship and the resulting FMA problem. The more moderate instance of the tragedy in the DIGILE case can be attributed to behaviors to circumvent the IPR problem and the fact that there were less direct competitors in the programs.

Another difference between the SHOKs may be the general perception of risk. First, the technology and product and/or service cycles are shorter, and new businesses are created more often in IT compared to forest-based industries. Second, risk magnitude is different, for example, comparing the programs Future Biorefinery (FIBIC) and Future Innovative Services (DIGILE), the investment in commercializing the concepts differs by two or more orders of magnitude.

Based on these findings, we argue that the program features are one facet of the explanation, as the cooperative setting with the OI regime creates disincentives for commercialization. As the consortium members have unlimited access to IPR, the possibility of escalating competition and the resultant risk inhibit innovation. Further, although IPR transfer ‘at a market price’ is possible, to buy out competitors, appropriability is already compromised and determining the price is difficult.

As discussed above, the FMA depends on market and technology change, and any first mover faces a high risk of failing altogether and bears the significant cost of attempting to create a market. In the case of FIBIC

the industry is mature, which might indicate a ‘stale’ market where FMA would be attainable; however, based on the data the program sets incentives that create a stalemate (c.f. Table 4).

Table 4: Comparison of industry/market factors between bio-refinery and IT industries (c.f., Pacheco-de-Almeida 2010; Hoppe and Lehmann-Grube 2001)

Market factors that risk escalation of competition	FIBIC (esp. Bio-refinery)	DIGILE
<i>Main target market for the RDI outputs</i>	Bio-based products, including liquid “bio-fuels”	Digital business and consumer services, digital service infrastructures
<i>Fast moving technology, short product cycle</i>	Biotechnology is science-based. The RDI cycle is long but moves fast compared to the industry standard	Historically, technology development has been fast
<i>Volatile markets</i>	The market size is unpredictable; the assumption is that it is growing	Overall, the market for IT is growing steadily, fast changes occur within and between segments, technologies and business models
<i>High R&D cost</i>	Moderate-high R&D cost; high investment cost	Moderate R&D cost; low-moderate investment in digital services
<i>Well-resourced enterprises</i>	Many large multinational enterprises	Large multinational enterprises, SMEs

5 Discussion

To summarize, both of the cases support the proposition of the reverse tragedy of the commons. While it is generally assumed that public goods tend to be overexploited, the reverse may be true when the risk of escalating competition and low appropriability create ‘perverse’ incentives. Based on the above-discussed cases, we consider factors that relate to the enterprises themselves and the framework conditions.

First, building competitive advantage on a public good is an oxymoron within RBV, as public information is not appropriable. In practice enterprises base decision on perceived asset and market position within the given appropriability conditions. Thus the likelihood of the reverse tragedy is the highest when the asset position is perceived to be equal among the competitors and smaller when the cooperative enterprises have clearly different asset positions and/or roles in the value chain.

P1: The likelihood of exploiting public IP correlates with the relative (perceived) asset position of the focal enterprise among its competitors

P1a: (Perceived) lack of complementary assets is a disincentive to exploit public IP

P1b: Poor perceived fit to scope and path of the enterprise is a disincentive to exploit public IP

P1c: The level of (second order) capabilities to assess the value of innovation and to exploit it are in direct relationship with the propensity to exploit public IP

Second, we propose the likelihood rises when the markets and/or technology are volatile and develop fast, entry barriers are low, and RDI costs are high and/or the competitors are well resourced. Similarly, the likelihood of escalation with expected low returns create a further disincentive for innovation. Effectively, these mechanisms create stalemate whereby enterprises wait, for each other to create a market. Thus, we further propose the following:

P2: The reverse tragedy is exacerbated by risk of escalation of competition that is associated with

P2a: Fast moving technology and short product cycles,

P2b: Volatile and/or uncertain market demand,

P2c: High RDI cost, and

P2d: An industry that consists of well-resourced enterprises.

Third, we may consider the factors that are related to the framework conditions that are established by the policy mix. The main precondition is low appropriability. The confounding factor is the horizontal nature of the consortia, i.e., including competitors from the same tier of the value networks within the consortia.

P3: Reverse tragedy is enabled by

P3a: Mandated IP (-R) sharing (in the extreme) or

P3b: Weak appropriability conditions, and

P3c: Consortia with partners who are in (direct) competition

Main limitation to the propositions is that we assume a degree of risk averseness, which is contrary to the usual underlying assumption in much of economics. The findings are corroborated by the findings that the more open enterprises are and the more intensive their competition, the stronger their preference to retain IPR (Hagedoorn and Zobel 2015), that high R&D costs can lead to a waiting game (Hoppe and Lehmann-Grube 2001), and that lower appropriability will lead to lower value creation (Kortelainen et al. 2011).

Although the findings of general benefits from OI seem to be robust across different contexts (Dahlander and Gann 2010; Laursen and Salter 2006; Chesbrough and Brunswicker 2013; van de Vrande et al. 2009), based on this exploratory account, it seems that enterprise as well as industry and market characteristics have an impact on how well OI works. OI arguably has or can have multiple societal and economic benefits,

but *ceteris paribus* weaker appropriability does not equal greater value creation, at least in the short to medium term. The implication for research is that the industry conditions may moderate the benefits of opening up innovation. This puts the nascent argument that ‘more open is better’ under a critical light (Ahn et al. 2016; Hippel and Krogh 2003; von Hippel and von Krogh 2006; Pénin 2011).

These behaviors are most likely in the conditions of poor appropriability and/or intensive collaboration. Such conditions would possibly suggest an oligopolistic industry in which a few enterprises are substantially larger than its network partners and others “cannot afford” not to engage with the network engines. Alternative or complementary explanations for these behaviors might include difficulties of overcoming organizational inertia, the not-invented-here syndrome, difficulty integrating the RDI and strategic alignment between consortium and internal RDI (e.g., West & Gallagher 2006; Dahlander & Gann 2010). This exploratory account cannot comprehensively rule out all alternative explanations, but the data suggest that the IP appropriability is a decisive factor.

Another test is the question: why would rational decision makers accept such an agreement while not being able to reap the benefit for the investment? In short, the reverse tragedy is a product of a ‘perfect storm’ of circumstances. The interviews indicated that the T&C took shape after initial commitment to the program. The decision makers operated with the best knowledge they had at the time and ‘promises were made.’ Further, the full picture of the relative asset positions and market conditions was revealed during the programs. Finally, a widely observed attitude was that due to the exceptional funding volume and commitment of several key players none ‘could afford’ to stay out.

These findings provide insight into the debate on OI. In ‘truly open’ innovation, where all results are public, theoretically, the (positive) externalities are the greatest. However, there is a risk of subversive behaviors and less incentive to conduct RDI that is related to the core business. Thus, in practice, some balance must be sought in openness. We cannot say definitely whether ‘truly open’ (c.f. Hagedoorn & Zobel 2015) innovation works, but the findings indicate that enterprises that come from a traditional IPR-ownership paradigm may not be amenable to engage.

The implication for management is that entering into OI needs consideration of the market and the collaborators intent. Even if an enterprise is not worried about their asset position, weak appropriability is conducive to poor partner behaviors. The common-sense corollary is to align incentives. Referring to the propositions, this includes aligning the strategic interests and asset positions of the collaborators to minimize conflict of interest and maximize value creation.

The parallel implication for policy is that while establishing OI regimes, the interplay between enterprise characteristics, industry structure and market framework needs to be considered to avoid a stalemate. The SHOK program adhered to the guidelines proposed for OI policies (de Jong, Kalvet, and Vanhaverbeke 2010), but the outcome is not as favorable as expected and hoped for. If the objective is to implement OI to maximize positive externalities, the incentives to engage in RDI and further commercialization of the outcomes must be aligned. Consortia formed around shared interests and ‘vertically’ along the value chain are likely more effective than large cooperative consortia. Additionally instruments that support market formation and legitimation could lower uncertainty and align incentives for innovation (c.f. Edler and Georghiou 2007; Aschhoff and Sofka 2009; Georghiou et al. 2013).

6 Conclusion

This paper has presented an exploratory empirical account of a phenomenon that we refer to as the reverse tragedy of the commons in an open innovation setting. Our main finding is that when information is a public good between a group of cooperative stakeholders, asset positions are similar, and the industry conditions give rise to the risk of competition, stakeholders tend not to commercialize IP from collaborative RDI. The reverse tragedy of the commons is named in this graphic manner because such an event not only is costly in terms of time and resources but also can, in fact, render IPR effectively worthless in terms of commercial exploitation. Thus such partnerships may actually hinder an industry in the short to medium term.

The main contribution of this paper is that it outlines a new phenomenon that informs management, policy making and contributes to exiting research. This finding is especially pertinent in the design of RDI policy measures that aim to foster collaboration. The main finding is that forcing partners to share knowledge is a double-edged sword. Even though positive externalities may hypothetically be greater, a reverse tragedy of the commons may in fact put the industry in a *cul de sac* as found in the cases.

The implication for management is that entering into collaboration in OI terms needs consideration of the market and industry conditions. In view of the propositions, one key point is alignment of the interests and asset positions of the collaborators to minimize conflict of interest and maximize value creation. Another key is to consider the incentives set by the policy mix and stress the dimensions of legitimation and market formation.

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